Model Driven Intelligent Control of Manufacturing

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Introduction

The Model Driven Intelligent Control of Manufacturing (MDICM) project has developed a new interface for reading product model data into machine tool controllers. The new interface allows 3-D solid model feature, inspection quality tolerance, process and tool information to be read into these controllers. When the new interface becomes a standard, the control vendors will be able to write software that makes machine tool controls easier to program and safer to operate using this new information. This in turn will make many manufacturing activities more productive. The MDICM project has estimated that industry will gain the following benefits as a direct result of the new interface.

— On average machining will become 50% faster because the new interface makes Multi-Axis and High Speed machines safer to operate so they will be used more often for the small to mid-sized job lots that by-value represent 75% of all machining.
— On average programming will become 35% faster because it is easier to create, edit and check control programs when they contain embedded 3-D model and feature information.
— On average 75% fewer drawings will be required on the shop floor because the data shared by the new interfaces is self-documenting so all the information required by shop floor operators can be extracted using web-browsers and other common tools.

The new MDICM interface replaces an older interface that transmits vector codes, called M & G codes, between CAD/CAM systems and CNC systems. This interface was developed in the 1970's when paper tape was a popular medium and only mainframe computers contained sufficient power to manipulate 3-D models. To promote the new interface the International Community is making the new interface into a new ISO Standard. The standard is known as AP-238 in the standards community and as STEP-NC in the wider world. It is currently under preparation to become a Draft International Standard.

As a result, there is now an opportunity to develop and market tools to prepare and process the new data on the CNC control. Some examples are a new programming environment for NC applications, a new planning tool for creating machine independent CNC control data, and a tool path compiler for processing the new data on the CNC control. The new compiler should be the most significant tool in the long term because it is a key to the future of manufacturing automation. The compiler takes the machine independent CNC files described by the AP-238 standard and converts them into execution instructions for a particular CNC machine. It can be configured for stand-alone use on a desktop or for "hands-free" use on a CNC. In the second mode, a STEP-NC control is constructed by:

1. Upgrading the control to be "open" by loading it with MS Windows or Linux compatible software and loading a CAM system.

2. Loading a STEP-NC compiler into the CAM system as a "plug-in" and linking it with a cutting tool database if one is available.

The net result is a control that reads STEP-NC data, compiles it for the machine, checks for collisions, and begins execution with minimum or zero intervention by the end user.

The tool path compiler makes Multi-axis and High Speed machines easier and safer to use by ordinary operators. These operators have little or no CAM training. They find it difficult to understand the old style M and G codes on Multi-axis machines because of the extra degrees of movement. Hence, they prefer to use 3-axis machines even though they are slower and require more fixtures. Using a Multi-axis machine is far more efficient because most parts can be made in a single set-up. The issue is finding a way for the operator to check the compatibility of the job against the configuration of the machine tool ***safely***. The new STEP-NC interface supplies this safety because the rich 3-D information it supplies let's algorithms on the control do full safety checking.

Figure 1 shows how STEP-NC was implemented for a pilot demonstration held at NASA JPL in January 2003. In this demonstration design data was converted into manufacturing data by a planning system developed for the MDICM program by Honeywell. The tool makes extensive use of feature recognition to make the conversion quick and easy to program. Its output is a file in the new machine independent format defined by AP-238. However, NASA and most other users would prefer to use their existing CAD/CAM systems to create STEP-NC data. This is one of the remaining barriers to wide deployment of STEP-NC. The other barriers include finishing the standard and getting international agreement that it will be the only new standard for CAM to CNC communication.

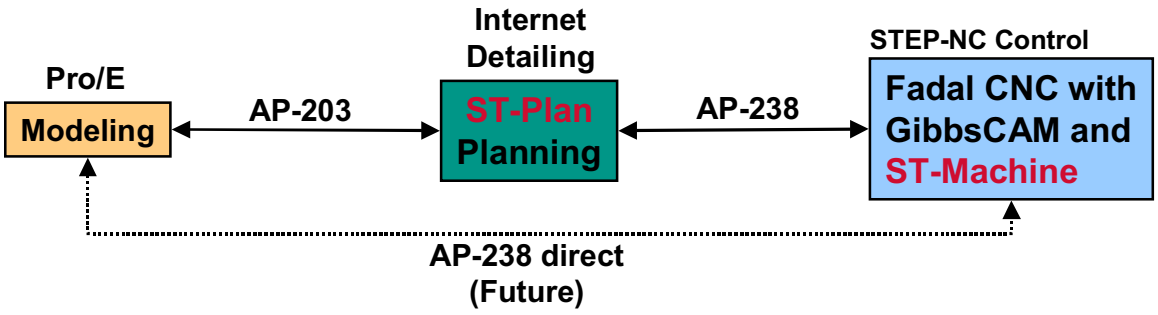

Figure 1. STEP-NC at JPL

The first sources of AP-238 data are now available. STEP-NC will enable new CNC applications that make machining faster and more accurate. They will be the catalyst for some important societal changes including much greater use of machining, much greater expectation for customized products, less waste and many new kinds of micro-machined products.